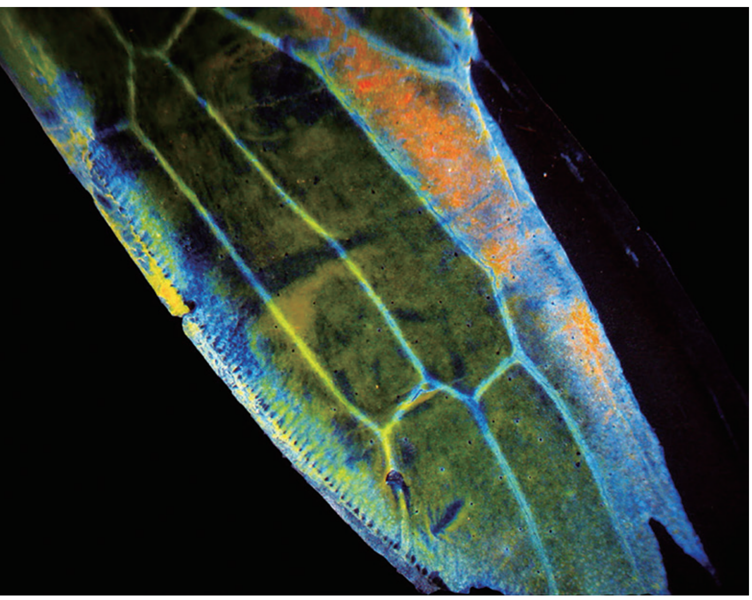
Unlocking the Secrets of Chitin Biosynthesis

By YAN Fusheng (Staff Reporter)

Have you ever wondered what makes the exoskeletons of insects, like ants and beetles, so strong and durable? Or what provides structural support to the cell walls of mushrooms? The answer to both questions is chitin, a remarkable natural material that is abundant in animal and fungal kingdoms.

Chitin is a long-chain polymer made up of N-acetylglucosamine, a molecule derived from glucose. It is the second most abundant natural polymer on Earth, after cellulose, and plays a crucial role in the structural integrity of many organisms. Chitin is the primary component of the exoskeletons of arthropods, such as insects, spiders, and crustaceans.



A close-up of the wing of a leafhopper; the wing is composed of chitin. (By Zituba, CC BY-SA 3.0)

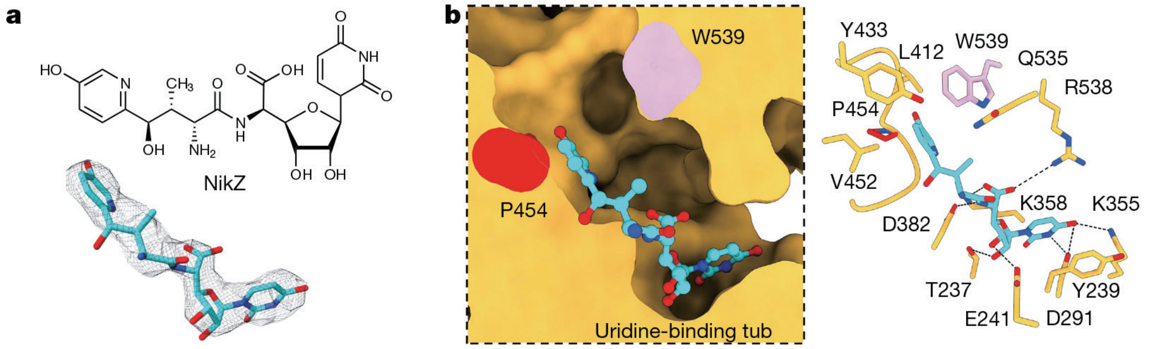
This wonder material is strong, flexible, and lightweight, making it the perfect building block for various biological structures. Despite its ubiquity in nature, the precise mechanism behind chitin biosynthesis has remained a mystery to scientists for many years. However, recent breakthroughs have unveiled some of the secrets behind this complex process.

In the October 13 issue of *Nature*, a team of scientists led by Dr. GONG Yong at the Institute of High Energy Physics of the Chinese Academy of Sciences and Dr. YANG Qing at the Institute of Plant Protection of the Chinese Academy of Agricultural Sciences reported five cryo-electron microscopy structures of a chitin synthase, namely *Ps*Chs1, from a devastating soybean root rot pathogen.

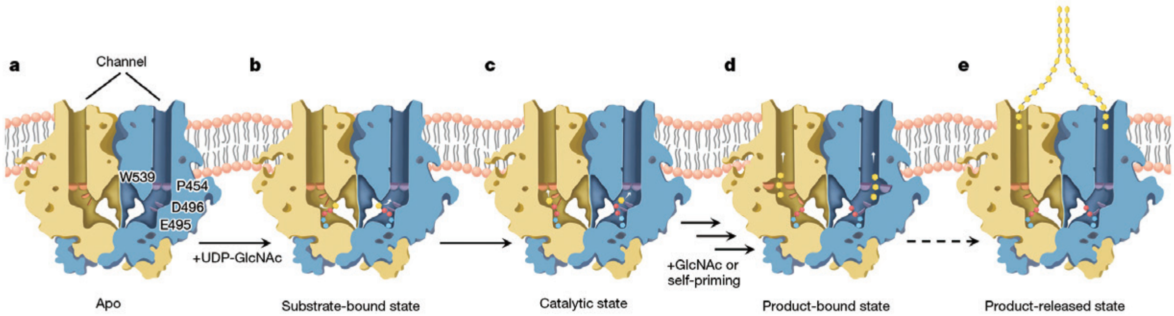
These structures represent various stages of chitin biosynthesis, from the initial substrate-binding to the release of the final product. The research has even provided insights into the enzyme's inhibition by the chitin synthase inhibitor nikkomycin Z (NikZ), which may open the door to new possibilities for controlling chitin synthesis in pests and pathogens.

The captured images reveal a chitin synthesis reaction chamber, complete with a substrate-binding site, catalytic center, and entrance to a polymer-translocating channel. This channel is responsible for discharging the synthesized chitin product to the extracellular side of the cell membrane. Through their research, the scientists have discovered a unique swinging loop mechanism within this channel, which acts as a "gate lock" to prevent the substrate from leaving and directs the polymer into the translocating channel for discharge.

This groundbreaking work has not only unveiled



Inhibition of the chitin synthase *Ps*Chs1 by NikZ. a, Chemical structure and electron density of NikZ. b, Sliced-surface view (left) of the NikZ-binding site and detailed interactions between NikZ and *Ps*Chs1 (right). (Credit: Chen *et al*./*Nature*)



A model of chitin biosynthesis. (Credit: Chen *et al*./*Nature*)

the directional multistep mechanism behind chitin biosynthesis but has also provided a structural basis for its inhibition. With this knowledge, we are one step closer to understanding the intricacies of this abundant natural material and harnessing its potential for various applications in agriculture, biotechnology, and beyond.

So, the next time you see an insect crawling around or enjoy a meal with mushrooms, remember that chitin is one of the key components that make these organisms strong and resilient. And who knows – in the future, we might see even more applications of chitin in our daily lives, from eco-friendly materials to innovative medical solutions.

Reference

Chen, W., Cao, P., Liu, Y., Yu, A., Wang, D., Chen, L., . . . Yang, Q. (2022). Structural basis for directional chitin biosynthesis. *Nature, 610*(7931), 402–408. doi:10.1038/s41586-022-05244-5